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Glossary of Limnological Terms

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Limnology is the study of freshwater systems. It is a science which incorporates a number of disciplines including biology, chemistry, physics, and mathematics. Because it encompasses so many areas it includes many terms. To understand or effectively communicate in limnology, one needs to be familiar with the terminology. That is the reason the following list was compiled. It is hoped that it can be used as a reference material by those persons who are beginning to study limnology or aquatic ecology, allowing them to escape the problem of becoming bogged down by the jargon.

abiogenic - not produced by the action of living organisms

absolute oxygen deficit - difference between the observed oxygen concentration in the water and the saturation value at 4°C at the pressure of the lake surface

absorbance (A) - the logarithm of the reciprocal of transmittance (T):

$$A = \log \frac{1}{T} = -\log T$$

absorption - lessening of light energy with depth by transformation to heat

acre - a unit of area equal to 43,650 ft^2, 4047 m^2 or 0.4047 ha

acre-foot - amount of water needed to cover an acre to a depth of one foot; it is equal to 43,650 ft^3

actual oxygen deficit - difference between the oxygen content observed at any depth and the saturation value of that same quantity of water at its observed temperature at the pressure of the lake surface

ADP - adenosine diphosphate; see ATP

adsorption - a type of adhesion which occurs at the surface of a solid or a liquid in contact with another medium, resulting in an increased concentration of molecules of that medium in the immediate vicinity of the surface of the solid or liquid

aerobic - living or active only in the presence of oxygen

AFDW - see ash-free dry weight

akinete - a thick-walled, reproductive spore peculiar to the blue-green algae. It is formed by the modification of a vegetative cell in which proteinaceous reserves in the form of cyanophycin granules are accumulated

algae - simple, photosynthetic plants with unicellular organs of reproduction and not possessing true roots, stems or leaves

alkalinity - is the capacity of water to accept protons and represents the buffering capacity of natural waters. Typically the alkalinity of many surface waters is primarily a function of carbonate ($CO_3^=$), bicarbonate (HCO_3^-), and hydroxide (OH^-) and therefore, is an indication of the concentration of these constituents. However, the measured values may also include contributions from borates, phosphates, sulfates, or silicates if these are present

allochthonous - arising within another biotope (Gr.-allos=other; chton=land)

allometry - the study of the change in proportion of various parts of an organism as a consequence of growth

alluvial - composed of alluvium, which is sediment deposited by flowing water

amictic lakes - lakes that do not undergo turnover, such lakes are sealed off constantly by ice from most of the annual variations in temperature

amplitude - the difference in height between the highest and lowest part of a wave

anabolic - one aspect of metabolic processes in which organisms synthesize complex molecules from simpler ones; compare catabolic

anerobic - living or active in the absence of free oxygen; may be obligate or facultative

angstrom (Å) - metric unit of measurement equal to 10^{-10} m

anion - an ion with a negative electrical charge

anisogamy - condition in which the gametes differ in size or motility and the larger or less active gamete (deemed the female) generally absorbs the other smaller or active gamete (deemed the male)

anoxia - deficiency of oxygen in the tissues

anthropocentric - interpreting reality exclusively in terms of human values and experiences

antibiotic - chemical substance produced by an organism that inhibits the growth of another organism or itself

aplanospores - non-motile asexual spores found in certain algae and fungi

arheic regions - hydrological regions within which no rivers arise. They are desert areas that occur in the latitudes of the trade winds and between which lies the zone of equatorial rains

ash-free dry weight (AFDW) - is the organic (ash-free) weight of a substance after it has been ignited at 550°C

assay - to examine by trial or experiment; put to a test; qualitative or quantitative determination of the components of a material

atmospheric pressure - is the pressure at any point in an atmosphere due solely to the weight of the atmospheric gases above the point concerned. Also known as barometric pressure. One atmosphere (1 atm) is the amount of pressure that will support a column of mercury (in a barometer) 76 cm high at 0°C. The pressure is equal to 14.7 pounds per square inch (psi). Approximately one atmosphere is gained for each 10 meters of water depth

ATP - adenosine triphosphate. A chemical that provides a common source of energy for a range of different cellular activities. One of the three phosphate groupings is readily transferred to other substances by enzyme activity, releasing a considerable amount of energy. ATP is formed from the addition of a phosphate (PO_4^-) to ADP utilizing light energy captured during photosynthesis or energy derived from catabolic processes

attenuation - generally, reduction in strength, size, quantity; lessening of radiation intensity due to absorption and scattering

aufwuchs - the community of organisms that are firmly attached to, or move upon, a substrate but do not penetrate into it. This is a German term that has a much broader meaning than periphyton, the nearest English equivalent

autochthonous - arising within the biotope under consideration (Gr.-autos= self; chthon=land)

autotroph - an organism that can provide its own nourishment, usually by the production of organic matter through the processes of photosynthesis

auxospores - in diatoms, large cells which develop from newly formed zygotes

auxotrophic - organisms requiring an external supply of organic compounds (such as vitamins) for their growth and maintenance

baroclinity - the state of stratification in a fluid in which surfaces of constant pressure (isobaric surfaces) intersect surfaces of constant density (isoteric surfaces)

barometric pressure - see atmospheric pressure

basalt - a dark-colored microcrystalline volcanic rock notable for the columnar forms in which it is often found

bathymetric - measurement of the depth of large bodies of water

Beer's Law - the law which states that the absorption of light by a solution changes exponentially with the concentration, all else remaining constant

Beer-Lambert Law - see Bouger-Lambert-Beer Law

benthos - organisms that live in or on the sediments

biliproteins (biloproteins) - a pigment-protein complex in which water-soluble pigments cannot be separated from a protein moiety. Like carotene they assist in photosynthesis by transferring light energy that they absorb to chlorophyll. Structurally they are similar to bile pigments in animals and were originally named phycobilins

bioassay - quantitative estimation of biologically active substances by the amount of their actions in standardized conditions on living organisms or parts of organisms

biogenic - produced by the actions of living organisms

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biogenic - produced by the actions of living organisms

biogenic meromixis - the condition in which there is only a partial mixing of a lake since a monimolimnion is formed in the lower stratum of water which is the consequence of biological origin. The monimolimnion is formed as the result of the accumulation of salts which are either liberated from the decomposition of sedimentary organic matter or the settling-out of organic matter from upper layers of water

biomass - the weight of all living (or organic) material in a unit area at a given instance in time

biota - animal and plant life (fauna and flora, respectively) characterizing a given region

biotope - a geographic region in which the environment is suitable for life

Birgean percentile absorption of light - the reduction in irradiance at a given depth in the water column expressed as a percentage of what amount of irradiance is impinging on the water surface. It is defined by the following equation:

$$100 \times \frac{(I_o - I_z)}{I_o}$$

where I_o = irradiance at the lake surface
I_z = irradiance at depth z, usually taken at 1 m intervals

bloom - a profuse growth of microscopic or semi-microscopic algae which may discolor the water, make it turbid, and many times cause it to be foul-smelling; usually of short duration but in some instances may be persistant

Bouger-Lambert-Beer Law - the intensity of a beam of monochromatic radiation in an absorbing medium decreases exponentially with penetration distance. Also known as the Beer-Lambert and Lambert-Beer Law

Boyle's Law - expresses the isothermal pressure-volume relation for a body of ideal gas. If temperature is held constant, the volume (V) of a given mass of gas is inversely proportional to the pressure (P) exerted upon it, or has a constant product (C). That is:

$$PV = C$$

Boyle-Charles' Law (or Ideal Gas Law) - the product of the pressure and volume of a gas is a constant (Boyle's Law) which depends on the temperature. Stated mathematically as:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

where: P_1 and V_1 are the pressure and volume of a body of gas at temperature T_1 (in °K), and
P_2 and V_2 are the pressure and volume of the same body of gas at temperature T_2 (in °K)

brackish - somewhat salty; less salt than seawater

breaker - the collapse of water over the front of an asymmetrical and unstable wave. They occur in an array of types ranging between two extremes which are plunging breakers and spilling breakers

^{14}C - is the radioactive isotope of carbon which has the atomic weight of 14

C-3 - name given to plant species in which the primary initial CO_2 fixation product is mostly a phosphorylated three-carbon acid called 3-phosphogylceric acid (3-PGA). It is the initial reaction of the Calvin cycle. Most plants are C-3 species

C-4 - name given to plant species in which the primary initial CO_2 fixation products are the four-carbon aspartic and malic acids. The reaction by which CO_2 (actually HCO_3^-) is converted to the four-carbon acids is through the initial combination with phosphoenolpyruvic acid (PEP) to oxaloacetic acid. Most C-4 species are monocots but a few are dicots. See Kranz anatomy

calcareous - resembling, containing or composed of calcium carbonate ($CaCO_3$)

calciphobic - intolerant of high calcium levels

caldera - basin formed by the subsidence of the roof a a partially emptied magmatic chamber. A more or less circular volcanic depression whose diameter is many times greater than that of the volcanic dent

Calvin cycle - the sequence of reactions leading from the incorporation of CO_2 to the more complex organic products produced in photosynthesis

carotenes - see carotenoid

carotenoid - a class of yellow, orange, and red plant pigments located in chloroplasts and in plastids in other plant parts where chlorophyll is absent. Not essential to, but assists in photosynthesis by absorbing light and passing the energy on to chlorophyll. There are two kinds of carotenoids, carotenes and xanthophylls. Carotenes are orange-yellow to red pigments which are linear unsaturated hydrocarbons that are converted to vitamin A in the animal liver. Xanthophylls are yellow pigments which are oxygenated derivatives of the linear unsaturated hydrocarbons of carotenes

catabolic - one of the two aspects of metabolic processes in which an organism breaks down (degrades) complex organix molecules into simpler ones with an associated release of energy

cation - an ion with a positive electrical charge

centric diatoms (Centrales) - a grouping of diatoms that exhibit radial symmetry, meaning they are capable of being halved in either of two (or more) planes so that the halves are apparently or approximately mirror images of each other

chelating agent - organic compounds which have a heterocyclic ring containing a metal ion attached by coordinate bonds to at least two non-metal ions in the same molecule

chelation - to form a stable ring compound by joining a chelating agent to a metal ion

chemocline - a term specific to meromictic lakes which refers to the stratum of water between the upper statum of water (mixolimnion) and the lower stratum (monimolimnion) and is characterized by a steep salinity gradient

chitin - an insoluble carbohydrate commonly found in the exoskeleton of insects and other arthropods; it also occurs in the cell walls of some algae

chlorophyll - the generic name for any of several oil-solube green tetrapyrrole plant pigments which function as photoreceptors of light energy for photosynthesis

chromatophores (chromoplasts) - pigmented plastids of plant cells

cirque - a steep hollow, often containing a small lake, occurring at the upper end of some mountain valley

clinograde - curve of temperature or of a chemical substance in water that exhibits a uniform slope (either positive or negative) from the surface downward into deeper water (Gr.-klinein=slope)

clinograde oxygen profile - is where the oxygen concentration is depleted in the lower depths of water

closed lakes - a lake with no outflow

coccoid - spherical or more literally "sphere-like" in shape

coefficient of eddy diffusion (A) - is a measure of the rate of or intensity of mixing (exchange) across a fluid plane. Important to note the A is inversely proportional to stability, i.e. as stability increases, A decreases

color - a general term that refers to the wavelength composition of light, with particular reference to its visual appearance

commensalism - of members of different populations living in close association in which one population is benefited and the other is not affected

conduction - transmission of energy by a medium which does not involve movement of the medium itself

conductivity - the ratio of the electric current density to the electric field in a material

convection - transmission of energy or mass by a medium involving movement of the medium itself

copepods - any of numerous small marine or freshwater crustaceans of the sub-class Copepoda which is in the class Crustacea

Coriolis effect (or force) - the diverting force of the earth's rotation which causes horizontally moving water or air particles to be diverted towards the right in the Northern Hemisphere and towards the left in the Southern Hemisphere

coulomb - a unit of electricity; a quantity of electricity equal to the charge on 6.25×10^{18} electrons; the quantity given by one ampere in one second

crop - total weight of organic matter removed from a given area over a period of time in the course of normal harvesting

cryogenic lakes - Arctic lakes formed from the effects of permafrost

currents - nonperiodic water movements generated by external forces which include the frictional exertion of wind stress, changes in atmospheric pressure, horizontal density gradients caused by differential heating or by diffusion of dissolved materials from the sediments, and the influx of water to a lake in relation to retention time and outflow

cyanophycin granules - proteinaceous granular storage products found in blue-green algal cells

cycloid - circular path or orbit

cyclomorphosis - periodically repeated changes in the body form of successive generations of planktonic animals

cyclonic - having a sense of rotation about the local vertical that is the same as the earth's rotation: as viewed from above, counterclockwise in the Northern Hemisphere, clockwise in the Southern Hemisphere and undefined at the Equator

Dalton's Law of Partial Pressures - the pressure of a mixture of gases is the sum of the partial pressures of the component gases. This is because it is characteristic of a mixture of gases that the component gases in many respects behave completely independent of one another

deltaic lakes - lakes formed in the areas of a river delta

dendritic - tree-shaped or branching

density - mass per unit volume, usually given in grams per cubic centimeter; see specific gravity

depth-area curve - see hypsographic curve

depth-volume curve - represents the relationship of lake volume to depth. The units of expression can be either in percent of the total lake volume above a specific depth or in volume units versus depth

detritus - finely divided settleable material suspended in the water: organic detritus arises from the decomposition of the broken-down remains of organisms; inorganic detritus is the settleable mineral materials

diapause - a period during which growth or development is suspended, accompanied by greatly decreased metabolism

dichotomy - branching which is characterized by successive forkings into two approximately equal divisions

dimictic lakes - lakes that circulate freely twice a year in the spring and fall and are directly stratified in summer and inversely stratified in winter

dioecious - male and female gametes are derived from different individuals

diploid - cells which have pairs of chromosomes, or twice the haploid number (2n)

dipole - in physics, a configuration in which a positive and a negative charge of equal strength are separated by a specified distance

diurnal - pertaining to or occurring in a day or each day; daily. Occurring or active during the daytime rather than at night

divalent - in chemistry, elements having a valence state of two

doline - a particular kind of solution lake that is very circular and conically shaped

drainage basin (catchment area) - in America, equivalent to watershed, which is the region or area drained by a river. In Europe, watershed refers to the ridge or crestline dividing two drainage areas

dry weight - the weight of an organism after having been dried to a constant weight at some specified temperature. Temperatures that have been commonly used range from 60° to 105°C

dune lakes - wind created lakes in arid regions formed by deflation or erosion of broken rock, or by the redistribution of sand

dyne - unit of force, equal to the force which imparts an acceleration of 1 cm sec^{-2} to a 1 gram mass

dystrophic - brown-water lakes with a very low lime content and a very high humus content, often characterized by a severe poverty of nutrients

ectogenic meromixis - a condition that results when some external event brings salt water into a freshwater lake or fresh water into a saline lake, resulting in a superficial layer of less dense, less saline stratum overlying a monimolimnion of denser more saline water

eddy - rotating region of fluid

effluent - something that flows out or forth

egress - a place or means of exit; an outlet

Einstein (E)-is defined as the number of quanta (photons) equal to Avogadro's number (6.02×10^{23}); that is, the number of quanta per molar volume

Ekman spiral - a theoretical representation that a wind blowing steadily over an ocean of unlimited depth and extent and uniform viscosity would cause, in the Northern Hemisphere, the immediate surface water to drift at an angle of 45° to the right of the wind direction, and the water beneath to drift further to the right and with slower and slower speeds as one goes to greater depths

electromagnetic wave - a propagating, oscillatory combination of an electric and a magnetic field resulting from the acceleration of an electric charge; a transverse wave whose electrical component is perpendicular to a magnetic component

endemic - taxa which have a restricted range within a given region and the distributional range is smaller than the geographic area under consideration

endogenous - produced from within; originating within

endorheic regions - hydrological regions within which rivers arise but never reach the sea. They occur between subtropical deserts and the tropical and temperate humid regions

enthalpy - the sum of the internal energy of a system plus the product of the system's volume multiplied by the pressure exerted on the system by its surroundings. Also known as heat content

entrainment - the transfer of fluid by friction from one water mass to another, usually occurring between currents moving in respect to each other; pulled or drawn along after itself

epilimnion - the turbulent superficial layer of a lake lying above the metalimnion which does not have permanent stratification (Gr.-epi=on; limne=lake)

epilithic - growing on or upon rock surfaces

epineuston - organisms adapted to living on the upper surface of an interface film

epiphytes - organisms that use plants as a substrata without penetrating into them and without withdrawing nutrient substances from them

epitheca - see frustule

eukaryotes (eucaryotes) - are organisms composed of eukaryotic cells. Where eukaryotic cells are distinguished by having the following:

1 - the nucleus separated from the cytoplasm by a nuclear membrane and the genetic material borne on a number of chromosomes that consist of DNA and protein
2 - nuclear division by mitosis
3 - cytoplasmic inclusions are membrane bounded organelles;

compare prokaryotes

euphotic zone - stratum of a lake into which sufficient light penetrates for active photosynthesis to take place; compare trophogenic zone

euryhaline - able to tolerate a wide range of salinity (Gr.-euru=wide); compare stenohaline

eutrophic - a multi-defined term usually implying a water body well supplied with nutrients and highly productive in terms of the formation of organic matter (Gr.-eu=well; trophein=to nourish)

evaporation - conversion of a liquid to the vapor state

evapotranspiration - water loss due to both evaporation and transpiration

exogenous - derived from or developed from external causes

exorheic regions - hydrological regions within which rivers originate and from which they flow to the sea. This regional type contains the major lake districts of the world and most lakes

exponential growth phase (log phase of growth) - is the time when the increase of the members of a population is changing exponentially. Mathematically it is written as:

$$\frac{dN}{dt} = rN$$

which states that the rate of increase of N (the number of organisms) with time is equal to r (the intrinsic rate of increase of the population) times N; where r is a constant and is defined as being equal to (b-d) and b is the birth rate and d the death rate of the population

extinction coefficient (n) - is the constant a in the Beer's Law relation: A = abc, where A is the absorbance, b the path length, and c the concentration of the solution. Now called absorptivity but formerly known as the absorbancy index, absorption constant, or extinction coefficient

extinction coefficient, total (η_t) - is the extinction coefficient for naturally occuring lake water which is defined as:

$$\eta_t = \eta_w + \eta_p + \eta_c$$

Where: η_t = natural total extinction coefficient
η_w = extinction coefficient of the water itself
η_p = extinction coefficient due to the particles suspended in the water
η_c = extinction coefficient due to the dissolved compounds or color in the water

facultative - capable of altering responses to varying environmental conditions; compare obligate

fall turnover - is the autumnal period of circulation of a water body

fermentation - a group of chemical reactions induced by living or non-living ferments (things that cause fermentation, i.e. yeast, bacteria, mold, enzymes) that split complex organic molecules into relatively simple substances; especially the anaerobic conversion of sugar to CO_2 and alcohol by yeast

fetch - distance over which the wind has blown uninterrupted by land

filament - a type of thallus consisting of one or more rows of cells, with or without a mucilaginous sheath

fjord (fiord) - a narrow, deep inlet of the sea between high cliffs or steep slopes

fluvial - pertaining to a river or stream, formed or produced by the action of flowing water

form resistance - is the decrease in sinking rate of a cell (v in Stoke's Law) caused by the shape of the alga relative to that of a sphere of equal density and volume

frequency (ν) - the number of wave crests (peaks in energy) passing a given point in a given interval of time. The frequency is equal to the velocity of light (c) divided by the wavelength (λ):

$$\nu = \frac{c}{\lambda}$$

fresh weight - is the weight of an organism without water adhering to it, equivalent to wet weight

frustule - a diatom cell wall consisting of two halves or valves. The upper valve is termed the epitheca, the lower valve the hypotheca

geostrophic - pertaining to the deflecting force that results from the earth's rotation

gross productivity (rate of gross production)- it is the observed or measured change in biomass, plus all predatory and non-predatory (respiration, excretion, death, or injury) losses divided by the time interval

gyrals - or swirls, are the patterns by which the surface currents of very large bodies of water circulate

haploid - cells containing only a single set of chromosomes, or n number of chromosomes

hard waters - waters containing large concentrations of alkaline earths derived from drainage of calcareous deposits. Usually taken as being greater than 100 mg $CaCO_3$ L^{-1} total hardness

hardness - originally a measure of the capacity of water to precipitate soap. Dissolved cations in the water combine with soap to form insoluble precipitates and delay the formation of lather. Precipitated materials from such hard water also form scale in vessels in which the water is heated. This effect is caused primarily by the salts of calcium and magnesium. Other polyvalent cations may also precipitate soap (e.g.-Al, Fe, Mn, Zn, and Sr) but their concentrations in most waters are insignificant compared to Ca and Mg

heat budget, annual (θ_A) - total amount of heat necessary to raise the water from the minimum temperature of winter to the maximum summer temperature

heat content of a body of water - is the amount of heat that would be released on cooling from its maximum temperature to 0°C

heat income, summer (θ_S) - amount of heat necessary to raise the temperature of the lake from an isothermal condition at 4°C to the maximum observed heat content

heat income, winter (θ_W) - amount of heat necessary to raise the temperature of the lake from its minimum heat content to 4°C

hectare (ha) - a metric unit of area equal to 10,000 m^2. A hectare equals 2.471 acres

Henry's Law - states that the mass of any gas which will dissolve in a given volume of liquid is directly proportional to the pressure of the gas (provided that the temperature remains unchanged)

heterocysts - specialized vegetative cells unique to blue-green algae, that develop a thick envelope over the cell wall except at the polar regions, in which the heterocyst is connected to adjacent vegetative cells by a pore channel. They lack phycobillins and an oxygen evolving photosystem and they are major sites of nitrogen fixation under aerobic conditions

heterograde - a curve for temperature or a chemical factor in a body of water that exhibits a non-uniform slope from the surface downward into deeper water (Gr.-heteros=other)

heterotroph - an organism which requires a supply of organic material from its environment for its metabolism

holomictic lakes - lakes that are completely circulated

holoplanktonic - composite of perennial species that are present throughout the year

hormogonia - short, slightly modified lengths of trichomes without differentiated cells that fragment from the parent trichome and that move by means of a gliding motion, they can develop into a new filament. It is a means of vegetative reproduction in blue-green algae

humic acids - any of various complex organic acids obtained from humus; insoluble in acids and organic solvents

humus - the amorphous, ordinarily dark-colored, colloidal matter in soil, a complex of the fractions of organic matter of plant, animal, and microbial origin that are most resistant to decomposition

hydrostatic pressure - is the pressure at a point in a fluid at rest due to the weight of the fluid above it

hypereutrophy - excessive eutrophy, extremely eutrophic

hypervolume - see niche

hypolimnion - the deep layer of a lake lying below the metalimnion and removed from the surface influences (Gr.-hypo=below, under)

hyponeuston - those organisms adapted to living on the underside of a surface film

hypotheca - see frustule

hypsographic curve (depth-area curve) - is a graphic representation of the relationship between the surface area of a lake and its depth. This relationship may be expressed in terms of percent of the lake area which is above water of a given depth, or in absolute units such as m^2, hectares, or km^2. The curve is constructed by plotting depth along the vertical axis (ordinate) and area along the horizontal axis (abscissa)

Ideal Gas Law - see Boyle-Charles' Law

inertial force - a term used to designate a force in a given coordinate system arising from the inertia of a parcel moving with respect to another coordinate system. For example, the Coriolis acceleration of a parcel moving with respect to a coordinate system fixed in space becomes an inertial force, the Coriolis force, in a coordinate system rotating within the earth

influent - flowing in or into

infrared (IR) - electromagnetic radiation having wavelengths greater than those of visible red light and shorter than those of microwaves (radar). The range is fron 0.76 microns (760 nm) to 990.6 microns

in situ - in the original location

interflow - condition in which an incoming flow of water to a lake has a greater density than that of the epilimnion but less than that of the metalimnion or hypolimnion of the lake it is flowing into, so that it enters as a plume at an intermediate depth

internode - a section of a plant lying between two seccessive nodes

inverse stratification - winter phenomenon of temperate lakes in which colder water lays over warmer water

in vitro - by derivation, means "in glass". In general it is applied to biological processes when they are experimentally made to occur in isolation from the whole organism

ion - an atom or molecularly bound group of atoms which has gained or lost one or more electrons and therefore has a negative or positive charge

ionization potential - energy required to remove electrons from the molecule

isogamy - condition in which gametes are similar, and not differentiated in respect to sexuality

isopleth - a line of equal or constant value of a given quantity with respect to either space or time

isothermal - having constant temperature

isotope - one of two or more atoms, the nuclei of which have the same number of protons but different numbers of neutrons

karst - a topography formed over limestone, dolomite or gypsum and characterized by sinkholes, caves, and underground drainage

Kelvin waves - are waves found in large lakes that are described by mathematical models in which geostrophic effects are taken into account and wave components decrease in amplitude as they move away from the shoreline

kettle lakes - lakes formed by the melting of isolated blocks of ice left behind in glacial till as glaciers retreated

Kranz anatomy - in German Kranz means "halo" or "wreath" and that is the appearance of the concentric arrangement of thick-walled photosynthetic cells surrounding the vascular bundles in the leaves of most C-4 plants

lacustrine - of or pertaining to a lake

lamellar - layered

laminar flow - nonturbulent flow of a liquid in layers near a boundary; organized unidirectional movement of a liquid or a gas. Streamline flow of an incompressible, viscous fluid; all particles of the fluid move in distinct and separate lines

langley (ly) - equals 1 cal cm^{-2}

Langmuir circulation - water movement induced by turbulent transport organized into vertical helical currents in the upper layers of a lake

latent heat of evaporation - the quantity of energy required to evaporate 1 mole, or unit mass, of a liquid, at constant temperature and pressure

latent heat of fusion - the increase in enthalpy accompanying the conversion of 1 mole, or unit mass, of a solid to a liquid at its melting point at constant temperature and pressure

leeward - situated away from the wind

lentic - standing bodies of water

Liebig's "Law of the Minimum" - under "steady state" conditions the growth and reproduction of an organism will be limited by the abundance of the substance that, in relation to the needs of the organism, is least available in the environment

light - the visible portion of the electromagnetic spectrum (380 to 780 nm)

lignin - an organic, complex aromatic compound that provides strength and rigidity to tissues in which it occurs

limnology - the study of freshwaters and the functional relationships and productivity of their communities and how they are affected by the dynamics of physical, chemical, and biotic environmental parameters

Lineweaver-Burk equation - the reciprocal of the Michaelis equation expressed as a formula for a straight line ($y = mx + b$), that is:

$$\frac{1}{V_o} = \frac{K_m}{V_{max}} \times \frac{1}{[S]} + \frac{1}{V}$$

This straight line, "double reciprocal" plot is preferred to the hyperbolic plot of the Michaelis equation as a means of determining V_{max} and K_m, since a straight line is more accurately drawn and extrapolated than a curve

littoral region - interface zone between the land of the drainage basin and the open water of the lake in which macrophytes grow or potentially could grow

long waves - waves in which the wavelength is long in comparison to and much greater than the amplitude. They are non-dispersive and travel at a speed independent of wavelength

lotic - flowing waters, e.g.-streams

lunar tide - the portion of a tide produced by the gravitational forces of the moon

lysis - destruction of cells through damage to or rupture of the plasma membrane

maars - volcanic craters created by violent explosion but not accompanied by igneous extrusion; frequently they are filled with water creating small circular lakes

macrophyte - a large plant; typically, one that is visible to the naked eye

marl - calcium carbonate ($CaCO_3$); actually, a deposit of crumbling earthy material composed principally of clay with magnesium and calcium carbonate; used as a fertilizer for lime deficient soils

maximum depth (z_m) - the greatest depth of the lake

maximum length (l) - distance of the lake surface between the most distant points on the lake shore

maximum width or breadth (b) - maximum distance on the lake surface at a right angle to the line of maximum length between the shores

mean depth ($\bar{z}$) - the volume divided by its surface area: $\bar{z} = \frac{V}{A}$

mean width ($\bar{b}$) - is equal to the area divided by the maximum length: $\bar{b} = \frac{A}{l}$

meromictic lakes - those lakes that have only a partial mixing, the primary upper layers do not mix with the lower portion

meroplanktonic - composite of intermittently occurring species in the plankton

mesotrophic - a water body that is moderately supplied with nutrients and has moderate production in terms of organic matter being fixed; it is intermediate to eutrophic and oligotrophic waters (Gr.-mesos=middle, trophein=to nourish)

metalimnion - the layer of water in a lake between the epilimnion and hypolimnion in which the temperature exhibits the greatest difference in a vertical direction. Words that are synonomous are sprunschicht (German), and discontinuity layer; thermocline is not really synonomous (Gr.-meta=between, limne=lake)

mho - a unit of conductance, equal to the conductance between two points of a conductor such that a potential difference of 1 volt between these points produces a current of 1 amp; the conductance in mhos is the reciprocal of its resistance in ohms; also known as siemans

Michaelis equation - if one experimentally measures the initial velocity (v_o) of a simple reaction in which a substrate (S) is being converted to some product (P) when it is being catalyzed by a given concentration of enzyme [e_o] under constant reaction conditions, one finds that v_o varies with the concentration of the supplied substrate [S]. Plotting v_o versus [S] results in a rectangular hyperbolic curve which means the relationship between these two entities must be definable in terms of the equation of a rectangular hyperbole. The experimentally derived equation which relates v_o and [S] is normally written as:

$$v_o = \frac{V_{max}\,[S]}{[S] + K_m}$$

and is known as the Michaelis equation. It should be noted that this makes no assumptions concerning the mechanism of the enzymatic reaction; it merely describes how v_o is observed to vary with [S], in regard to the two experimentally derived constants V_{max} and K_m. These constants (or kinetic parameters) are defined as follows:

V_{max} is the maximum value of v_o which occurs at high concentrations of substrate; that is, V_{max} is independent of [S] so long as it is saturating. It is measured in units of quantity of substrate transformed per unit time for a given quantity of enzyme

K_m (called the Michaelis constant) can only be derived experimentally and equals the substrate concentration [S] at which the reaction is proceeding at half its maximum velocity; that is, $v_o = \frac{1}{2}V_{max}$. Values for K_m are expressed in units of concentration

Michaelis-Menten equation - is written as:

$$v_o = \frac{V_{max}\,[S]}{[S] + K_s}$$

which has the same form as the experimental Michaelis equation but differs in that it attempts to explain the significance of V_{max} and K_m in terms of the mechanism of an enzyme catalyzed reaction. It is based on a two-step mechanism in which there is an initial combination of enzyme (E) with its substrate (S), to form an enzyme-substrate complex (ES), a reversible process, which in turn results in the enzyme being regenerated and a product (P) being formed in an irreversible process. This can be expressed in the following manner:

$$E + S \longleftrightarrow ES \longrightarrow E + P$$

In the Michaelis-Menten equation, K_s is the dissociation constant for the enzyme-substrate complex going back to the enzyme and substrate

microcrustacea - microscopically small crustaceans

microeinstein (μE) - 10^{-6} Einsteins or 6.02×10^{17} quanta

micrometer (μm) - a micron

micron - unit of length that is equal to 10^{-6} m

millimicrons - unit of length equal to a nanometer

miscible - liquids that are mutually soluble (L.-miscere=to mix)

mixolimnion - the upper stratum of water which periodically circulates in meromictic lakes

mixotrophic - an organism capable of assimilating its own organic constituents from inorganic precursors but also requiring external sources of organic compounds

monimolimnion - the deeper stratum of water that is perennially stagnant in meromictic lakes

monoecious - gametes are derived from the same individual

monomictic lakes, cold - lakes with water temperatures never greater than 4°C and with only one period of circulation in the summer at or below 4°C

monomictic lakes, warm - in these lakes temperatures do not drop below 4°C, they circulate freely in the winter at or above 4°C and they stratify directly in the summer

moraine - an accumulation of glacial drift (till) deposited by direct glacial action

morphology - structure and form of an organism

mucilaginous - characterized by having a sticky organic substance made of polysaccharides that form chemical bonds with water

nanometer (nm) - unit of length that is equal to 10^{-9} m

nannoplankton - organisms of small size suspended in the open water which cannot be collected by net.; see plankton sizes (Gr.-nannos=dwarf)

net productivity - the gross rate of production of organic matter less losses, divided by the time interval

neuston - the microscopic component of the pleuston; divided into the epineuston (living on the upper surface) and the hyponeuston (living on the under surface)

niche - a multi-defined term that includes the physical space occupied by an organism and also its functional role in the community

node, or nodal region - that area of a plant from which lateral organs or branches develop; a multicellular area which bears sex organs

nomogram (nomograph) - a chart of an equation containing three variables by means of three scales. A straight line cuts the three scales in values of the three variables satisfying the equation

O_3 - ozone, an allotropic form of oxygen, containing three atoms in the molecule; having a characteristic odor a little like chlorine; a powerful oxidizing agent

obligate - absolutely, indispensable; essential; compare facultative

oligomictic lakes - lakes with few mixings, generally tropical lakes that have rare periods of circulation at irregular intervals and temperatures always well above 4°C

oligotrophic - waters low in nutrients with low organic production (Gr.-oligos=small, trophein=to nourish)

oogamy - sexual reproduction in which a large, non-motile female gamete (egg) is fertilized by a small, flagellated male gamete (antherozoid)

open lake - a lake that has an outflow

optical density - see absorbance

orthograde - a stratification curve for temperature or a chemical factor in a body of water which has a straight uniform course (Gr.-orthos=straight)

osmosis - the spontaneous movement of a solvent from one region in a solution where its activity is high, to another region where its activity is low, the regions being separated by a semi-permeable membrane

osmotic pressure - the pressure which must be exerted on a solution to prevent any net movement of solvent between the solution and its pure solvent when they are separated by a semi-permeable membrane

overflow - a term describing the condition in which an incoming flow of water to a lake has a lesser density than that of the lake it is flowing into and thus flows over the top of the lake water

oxbow lake - a crescent-shaped, relatively shallow lake formed under certain conditions by a meandering river

oxygen deficit - the difference in the amount of oxygen present at the beginning and at the end of stratification below a given depth

oxygen deficit, absolute - difference between the observed oxygen concentration and the saturation value at 4°C at the pressure of the lake surface

oxygen deficit, actual - difference between the oxygen content observed at any point and the saturation value of that same quantity of water at its observed temperature at the pressure of the lake surface

oxygen deficit, relative - difference between the oxygen content of the hypolimnion and that empirically determined at the end of spring turnover

PAR - or PhAR, see photosynthetically active radiation

parthenogenesis - development of an egg into a new individual without being fertilized. Eggs which develop in this way are usually diploid so all offspring are genetically identical to the parent

partial (or temporary) meromixis - is when a normally dimictic lake skips a period of circulation, usually the spring one

partial pressure - the pressure that would be exerted by one component of a mixture of gases if it were present alone in a container; see Dalton's Law of Partial Pressures

particulate matter - matter in the form of small liquid or solid particles

paternoster lakes - a chain of small lakes in a glaciated valley resembling a string of beads

peat - a dark-brown or black material produced by the partial decomposition and disintegration of mosses, sedges, trees, and other plants that grow in marshes and other wet places

pectin - complex colloidal substances of high molecular weight found in cell walls of unlignified tissue

pelagic - the region of open waters in seas and inland lakes

pennate diatoms (Pennales) - a grouping of diatoms that exhibit bilateral morphology, meaning their shape is such that it is capable of being halved in one and only one plane in such a way that the two halves are approximately mirror-images of each other

perennation - of plants, survival from year to year by vegetative means

periphyton - the community of organisms that are sessile or attached to any submerged substrate; compare aufwuchs

perturbation - state or condition of being disturbed or agitated

phaeopigment - degradation products of plant pigments

phagotrophic - able to ingest solid particles

photic zone - surface zone of a body of water sufficiently illuminated for photosynthesis, also called the euphotic zone

photoassimilates - compounds resulting from photosynthesis

photoautotrophic - of an organism, independent of outside sources of organic substances for provision of its own organic constituents, which it can manufacture from inorganic material using energy that is derived from sunlight

photoheterotrophic - of an organism, that requires an external source of organic substances and derives the energy for transformations of these compounds from sunlight

photon - see quantum

photophosphorylation - coupling of phosphate with ADP to make ATP (which is a phosphorylation process) using light energy absorbed in photosynthesis

photorespiration - type of respiration characteristic of certain plant species that is activated by light. Biochemically different from normal respiration since in this process CO_2 is generated as a result of glycolic acid, a direct product of the Calvin cycle. Plants displaying photorespiration have higher CO_2 compensation points and photosynthetically are less efficient than those which do not; these two types of plants also differ in other significant and apparently interrelated aspects. Besides the biochemical differences they also display anatomical differences

photosynthesis - conversion of incident light to chemical energy through the synthesis of organic matter (carbohydrates) from CO_2 and water, with the simultaneous release of oxygen. The incident light is converted into chemically useful energy at two kinds of reaction centers. One of them is called Photosystem I, it generates reducing power in the form of NADPH, whereas the other, Photosystem II, splits water to produce O_2 and generates a reductant

photosynthetic efficiency - is the ratio of the caloric equivalent of integral (entire) photosynthesis to the caloric value of the radiation inputs; values range from less than 0.01 to about 3 percent

photosynthetically active radiation (PAR, or PhAR) - that region of the electromagnetic spectrum between 400 to 700 nm.

phototactic - the movement of an organism in response to a source of light

phototrophic - of organisms obtaining energy from the radiation of the sun

phycobilin - red (phycoerythrin) and blue (phycocyanin) protein-bound pigments which are open-chained tetrapyrroles and occur in some groups of algae; see biliproteins

phycocyanin - a blue pigmented phycobilin

phycoerythrin - a red pigmented phycobilin

phytoplankton - small plants that have no or very limited powers of locomotion and are subject to distribution by water movements

piedmont - lying at the foot of a mountain or mountain range

Planck's constant (h) - a universal constant relating the energy of a photon to the frequency of radiant energy that emitted it; its numerical value is 6.624×10^{-27} erg-seconds

planimeter - an instrument that measures the area of a plane figure as a mechanically coupled pointer traverses the figure's perimeter

plankton - the community of the free water which are passively floating or weakly motile aquatic plants and animals (Gr.-planktos=wandering)

plankton sizes - catergorization of plankton based on their size ranges:

macroplankton - greater than 500 μm
microplankton - ≈ 50 to 500 μm
(net plankton)
nannoplankton - 10 to ≈ 50 μm
ultraplankton - 0.5 to 10 μm

plasmalemma - external plasma membrane in plants

plastids - small, variously shaped bodies in cytoplasm of plant cells containing pigments and/or reserve food materials

platinum units - a comparative color scale utilizing a specific mixture of platinum-cobalt compounds

playas - large pans or nearly level areas at the bottom of a desert basin, sometimes temporarily covered by water

pleuston - community of organisms adapted to the interface habitat between air and water, (i.e. the water's surface)

plunge-pool lakes - are lakes formed at the base of a waterfall

polymictic lakes - these are lakes with frequent or continuous circulation. There are cold polymictic lakes, circulating at temperatures near or slightly above 4°C. There are also warm polymictic lakes that exhibit frequent circulation at temperatures well above 4°C.

polymorphism - having several different forms

polyphotic - adapted to a wide range of light intensities

primary productivity - rate at which radiant energy is stored by the photosynthetic activity of producer organisms (green plants) in the form of organic substances

pristine - pertaining to, or typical of the primitive or original conditions; unspoiled

production - the weight of new organic material formed over a period of time, plus any losses during that period due to respiration, excretion, secretion, injury, death, or grazing

productivity - is the rate of production expressed as production divided by the period of time. It is important to remember that it is a rate function, an amount of energy fixed in a given amount of time; see primary productivity, secondary productivity, gross productivity, and net productivity

progressive wave - a wave which transfers energy from one part of a medium to another, in contrast to a standing wave. Also known as a free-traveling wave

prokaryotes (procaryotes) - organisms composed of prokaryotic cells. Where prokaryotic cells are characterized by having the following features:

1 - they are undifferentiated and lack internal membranes which separate the nucleus from the cytoplasm and which isolate the enzymatic machinery of photosynthesis and respiration into specific organelles (that is, no mitochondria, chloroplasts, etc. can be distinguished)
2 - reproduction is usually by binary fission and nuclear division does not occur by mitosis
3 - the cell wall contains a specific mucopeptide (protein containing carbohydrates) that acts as a strengthening component

compare eukaryotes

pseudoraphe - in diatoms, a depression of the cell wall

pyranometer - an instrument used to measure the combined intensity of incoming direct solar radiation and diffuse sky radiation; compares heating produced by the radiation on blackened metal strips with that produced by an electric current. Also known as a solarimeter

pyrrole - C_4H_5N, a five membered heterocyclic (not all of the same elements in the ring) compound that is a water insoluble, yellowish oil with a pungent taste; soluble in alcohol, ether, and dilute acids

quantum (or photon) - elementary unit or packet of energy of which light (electromagnetic radiation) is composed (L.-quantus=how much)

quantum energy (E) - the energy (E) of a quantum or photon is equivalent to the frequency (ν) of the radiation times Planck's constant (h):

$$E = h\nu$$

A photon's energy is directly proportional to the frequency of radiation and higher frequencies have more energetic photons. Since the frequency is equal to velocity divided by the wavelength ($\nu = c/\lambda$) then,

$$E = h(c/\lambda)$$

Thus, the energy of a photon is inversely proportional to wavelength and longer wavelengths (lower frequencies) have less energetic photons

quiescent - inactive or still; dormant

radiant energy - energy in the form of waves or pulsations and is said to be electromagnetic. Certain concepts and equations describe the wave nature of radiant energy while others describe the particulate nature of this energy. The "particles" or "packets" of radiant energy are termed quanta or photons

radiant energy terms - there are two sets of terminology for expressing this energy. One is in physical terms, called radiometric terminology, the other is in psychophysical terms, called photometric (or illumination) terminology which are defined in terms of the sensitivity of the human eye. The former is the preferred means of expression for the biologist since most of the radiant energy work has to do with photosynthesis; plants respond in quite different ways to the electromagnetic spectrum than does the human eye

Radiometric Terminology

Quantity	Units	Abbreviation	Defining Statement
Radiant energy	Joules calories ergs	J cal erg	Physical entity which has the capacity to do work
Radiant flux	Watts(=joules per second) calories per minute ergs per second	W(=J sec^{-1}) cal min^{-1} erg sec^{-1}	Radiant energy falling upon a surface in an interval of time; energy per unit time is power
Radiant emittance	Watts per square meter (=joules per second per square meter) calories per minute per square centimeter ergs per second per square centimeter	W m^{-2} (=J sec^{-1} m^{-2} cal min^{-1} cm^{-2} erg sec^{-1} cm^{-2}	Radiant flux density emitted per unit area of surface
Irradiance	same as above	same as above	Radiant flux density received per unit area of surface

Photometric (or Illumination) Terminology

Luminous energy	-	-	Radiant energy expressed as psychophysical entity
Luminous flux	Lumens	lm	Luminous energy evaluated with respect to its ability to invoke a response by the human eye; has the dimensions of power

Note: The lumen does not correspond to a definite number of watts except at a specific wavelength

Photometric Terminology (continued)

Quantity	Units	Abbreviation	Defining Statement
Luminous emittance	Lumens per square meter lamberts(= 1 lm cm^{-2})	lm m^{-2}	Luminous flux density emitted per unit area of source
Illuminance	Lumens per square meter (= 1 lux) phot(= 1 lm cm^{-2}) footcandle (= 1 lm ft^{-2})	lm m^{-2}(= 1 lx) fc or ft-c	Luminous flux density received per unit area

Radiant energy density is usually measured with a pyrheliometer, radiometer, or actinometer while luminous energy density is usually measured with a suitably filtered selenium photocell. The interconversions between the two systems is difficult and requires the careful calibration of the devices.

Many radiation measures are given in W m^{-2} or cal min^{-1} sec^{-1} while light measurements are given in ft-c. The relationship between irradiance units and illuminance units depends on the spectral composition being received. An approximate conversion factor for a flat spectral distribution curve over the 400 to 700 nm range is:

$$1 \text{ W m}^{-2} = 21.9 \text{ ft-c}$$

relative depth (z_r) - maximum depth as a percentage of the mean diameter:

$$z_r = \frac{50 \cdot z_m \cdot \sqrt{\pi}}{A_o}$$

relative oxygen deficit - difference between the oxygen content of the hypolimnion and that empirically determined at the end of spring turnover

renewal time - the amount of time it takes for the entire water body to be replaced; turnover time

reservoir - a body of water collected and stored in a natural or artificial lake

Richardson number (R_i) - dimensionle s number of fluid mechanics used in studying the stratified flow of multi-layered systems. Equal to the acceleration of gravity (g) times the density gradient of a fluid (ρ), divided by the product of the fluid's density and the square of its gradient at a wall

ripples - waves on a fluid surface of sufficiently short wavelength, less than 6.28 cm (2 pi), in which the surface tension of that fluid acts as the restoring force

salinity - the quality of being saline; saltiness; ionic composition of an aqueous solution, in freshwaters it is best expressed as the sum of the eight major cations and anions (Ca^{+2}, Mg^{+2}, Na^{+1}, K^{+1}, HCO_3^{-1}, CO_3^{-2}, SO_4^{-2}, and Cl^{-1}) in mass or milliequivalents per liter

saturation - the condition in which a further increase in some cause produces no further increase in the resultant effect

scenescence - growing old

Secchi disk transparency - is the mean depth of the point where a weighted white disk, 20 cm in diameter, disappers when viewed from the shaded side of a vessel, and the point where it reappears upon raising it after it has been lowered beyond visibility

secondary productivity - rate at which energy is stored at the consumer levels, i.e.-herbivores, carnivores, and detritivores

sedentary - attached, stationary; sessile or stalked

sediment - a mass of organic or inorganic solid fragmented material, or the solid fragment itself, suspended in, carried by, or dropped by air, water, or ice

seiche - a standing wave (surface or internal) oscillation of an enclosed or semi-enclosed body of water that continues, pendulum fashion, after the cessation of the originating force, which may have been atmospheric or seismic. Perhaps from the French word "seche" which means dry, since part of the shore is sometimes laid bare by the recession of the water

sequestering agents - chemical compounds that inhibit or prevent normal ion behavior by combining with other materials, especially the prevention of metallic ion precipitation from solution by the formation of a coordination complex with a phosphate

serial dilution - sequential dilutions of an initially concentrated amount

sessile - permanently attached or fixed; not free-moving; sedentary

seston - all particulate matter suspended in water (Gr.-sestos-strained)

Shannon-Wiener function - is a species diversity index that combines the number of species with equitability or the evenness of allotment of individuals among species:

$$H = -\sum_{i=1}^{S} (p_i) \cdot (\log_2 p_i)$$

Where: H = information content of sample (bits/individual) = index of species of diversity
S = number of species
p_i = proportion of total sample belonging to ith species

This function was derived independently by Shannon and Wiener and is sometimes mislabeled the Shannon-Weaver function

shoreline (L) - intersection of the land with the water

shoreline development (D_L) - the ratio of the length of the shoreline (L) to the length of the circumference of a circle of area equal to that of the lake:

$$D_L = \frac{L}{2\sqrt{\pi A_o}}$$

A D_L value of one means that the lake has a circular shoreline, the more it deviates from one the more convoluted the shoreline

shortwaves - waves in which the wavelength is less than the water depth. They are dispersive and travel at speeds proportional to the wavelength raised to the ½ power ($\lambda^{\frac{1}{2}}$)

siemens - see mhos

siliceous - containing or consisting of silica (SiO_2)

soft waters - waters containing low concentrations of ionic species and are usually derived from drainage of acidic igneous rocks. Usually taken as being less than 50 mg $CaCO_3$ L^{-1} total hardness

solar constant - the amount of direct solar radiation per unit of time from the sun, incident upon a surface just outside the earth's atmosphere perpendicular (normal) to the rays of the sun at the earth's mean distance from the sun

solution lakes - lake basins formed by the dissolution of the bedrock materials

specific heat - that amount of heat in calories that is required to raise the temperature 1°C of a unit weight of a substance

specific gravity - the ratio of the density of a substance to the density of water

stability per unit area of a lake (S) - is the quantity of work or mechanical energy in ergs required to mix the entire volume of water to uniform temperature by the wind, without the addition or subtraction of heat

standing crop - weight of organic material that can be sampled or harvested by normal methods at any one time from a given area

standing waves - disturbances that are not progressive. Standing waves result from the superposition of two waves traveling in opposite directions, having identical amplitudes and frequencies. The wave disturbance is maximal at certain points occurring periodically, called loops or anti-nodes, and it is zero at points between them, called nodes

steno - having a narrow range (Gr.-stenos=narrow)

Stoke's Law - is the relationship applicable to the motion of a small spherical body in a fluid under gravitational attraction; the body attains a constant velocity (V), equal to:

$$V = \frac{2gr^2(P_S - P_F)}{9n}$$

Where: g = the acceleration due to gravity; = 980.665 cm sec^{-2}
r = the radius of the sphere
P_S= the density of the sphere
P_F= the density of the fluid
n = the viscosity of the fluid

stratification - horizontal layering of waters of differing densities; usually the density differences are produced in a lake as the result of temperature changes at various depths

summer kill - a catastrophic event that occurs under certain conditions (usually late summer in a shallow eutrophic lake) in which the oxygen content is severely reduced to almost complete anoxia and there are massive die-offs of many species of fauna

supersaturation - the condition of containing an excess of some material over the amount required for saturation

surface waves - are waves of distortion on the free-surface separating two fluid phases, usually a liquid and a gas or vapor of low density. The waves are classified as gravitational waves or ripples, depending on whether gravity or surface tension is the controlling force in their motion

symbiotic - the association of dissimilar organisms to their mutual advantage

tectonic - pertaining to, causing or resulting from the structural deformation in the earth's crust

temperate - pertaining to the geographic region which lies between the latitudes 23.5° and 66.5°

thallus - a plant body which is not differentiated into true roots, stems, or leaves

thermal bar - a narrow transitional zone between the open water mass and littoral stratified water in which the water is nearly a vertical 4°C isotherm

thermocline - is the plane or surface of maximum rate of decrease of temperature with respect to depth

Thermodynamics, First Law of - states that the total energy of an isolated system is constant, that is, it can neither be created or destroyed but it can be transformed from one type into another

Thermodynamics, Second Law of - states that in a closed system the only reactions that can occur spontaneously are those that increase the total entropy (a measure of disorder) of the system and its surroundings

thermokarst lakes - Arctic lakes formed by the coalescing of small cryogenic lakes into a larger pond

thermophilic - requiring high temperatures for normal development with optimum growth temperatures being above 45°C

transmittance (T) - is the fraction of light transmitted by a substance expressed as decimal fraction:

$$T = \frac{I}{I_o}$$

Where: I = intensity of transmitted radiant energy
I_o = intensity of incident radiant energy

transparent - having the property of transmitting light without appreciable scattering so that bodies lying beyond are entirely visible

transpiration - the evaporation of water from plants

trichome - is the basic structural unit of a filamentous blue-green alga consisting of a linear row of cells, minus a mucilaginous sheath

trophogenic zone - superficial stratum of a lake in which photosynthetic production occurs, it is when organic products are made from mineral substances on the basis of light energy

tropholytic zone - aphotic deep stratum of a lake where heterotrophic decomposition of organic matter takes place

turbidity - is a condition in which sediment or other particulate matter is stirred-up or suspended in the water column, giving it a muddied or cloudy appearance

turbulent flow - motion of fluids in which local velocities and pressures fluctuate irregularly, in a random manner

turgor pressure - pressure exerted against the cell wall by its internal contents swelling the cell

turnover - circulation of a water body; usually in reference to temperate lakes

ultraviolet (UV) - range of electromagnetic radiation extending from about 4000 angstroms (400 nm), just beyond the violet in the visible portion of the spectrum, to about 40 angstroms (4 nm), on the border of the x-ray region

μmhos - micro-mhos, 10^{-6} mho

valve - in diatoms, one half of the wall of the cell; two together constitute the entire cell wall which is called the frustule

vapor pressure (or saturation vapor pressure) - of a substance (solid or liquid) is the pressure exerted by its vapor when in equilibrium with the substance; for pure substances it depends only on the temperature

variegated - having streaks, marks or patches; distinguished or characterized by variety; diversified

vernal - pertaining to spring

viscosity - internal friction of a fluid, that is, the force between particles in the fluid which causes a resistance to flow; a property of fluids is a shearing stress which gives the coefficient of viscosity of a particular fluid when divided by the rate of shear; the poise is a metric unit of viscosity; viscosity varies inversely with temperature

volatile - evaporating readily at normal temperatures and pressures; capable of being readily vaporized

volume (V) - the volume of the lake basin is the integral of the areas of each stratum at successive depths from the surface to the point of maximum depth

vortex - any flow possessing a rotary motion

vortical motion - motion of a fluid (as at the boundary layer between two layers flowing in opposite directions) in which each individual particle rotates about its own axis. Also called rotational motion

wave - a disturbance which propagates from one point in a medium to other points without giving the medium as a whole any permanent displacement

wavelength (λ) - the distance between waves or crests of energy in electromagnetic radiation. The wavelength is equal to the velocity divided by the frequency:

$$\lambda = \frac{c}{\nu}$$

Where: $c = 2.998 \times 10^{10}$ cm sec^{-1} (the speed of light)
ν = frequency (sec^{-1})

wave number (ν' or k) - a term that is convenient in some applications and equal to the reciprocal of the wavelength which is measured in centimeters:

$$\nu' = \frac{1}{\lambda}$$

wet weight - see fresh weight

wind factor - ratio of water velocity of surface currents to wind velocity

Winkler titration - a chemical method for estimating dissolved oxygen in water. Manganous hydroxide is added to the sample and reacts with oxygen (if present) to produce a manganese compound which in the presence of acid potassium iodide, liberates an equivalent quantity of iodine that can be titrated with a standard solution (usually sodium thiosulfate)

winter kill - massive die-offs of many species of fauna in a body of water due to conditions of low oxygen content or anoxia during the winter

xanthophyll - see carotenoid

yield - is the crop expressed as a rate

zooplankton - the animal portion of the plankton (Gr.-zoion=animal)

zygote - a diploid cell resulting from a union of sex cells; a fertilized egg